SPECIFICATION

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[A GOLF CLUB HEAD WITH A FACE INSERT (Corporate Docket PU2101)]

Cross Reference to Related Applications

Not Applicable

Federal Research Statement

[Not Applicable]

Background of Invention

[0001] Field of the Invention

[0002] The present invention relates to a golf club head. More specifically, the present invention relates to a golf club head with a face insert.

[0003] Description of the Related Art

[0004] High performance drivers employ relatively thin, high strength face materials. These faces are either formed into the curved face shape then welded into a driver body component around the face perimeter, or forged into a cup shape and connected to a body by either welding or adhesive bonding at a distance offset from the face of up to 0.75 inch. In a popular embodiment of the sheet-formed face insert driver, the weld between the formed face insert and the investment cast driver body is located on the striking face, a small distance from the face perimeter. It is common practice for the face insert to be of uniform thickness and to design the surrounding driver body component to be of equal thickness. In this way there is continuity of face thickness across the weld.

[0005] Most face inserts are composed of a titanium alloy material. Titanium alloys are generally classified into three types depending on the microstructure of the material developed after processing of the material. The three types are alpha alloys, alpha-beta alloys and metastable alloys, and these represent the phases present in the alloy at ambient temperatures. At ambient temperatures, the thermodynamic properties of titanium favors the alpha phase. However, alloying titanium with other elements allows for the high temperature beta phase to be present at ambient temperatures, which creates the alpha-beta and metastable beta microstructures. The metastable phase may be transformed into the alpha phase by heating the alloy to an intermediate elevated temperature, which results in a metastable titanium alloy with increased static strength.

[0006] Such high strength metastable titanium alloys have been used as face inserts for drivers with a high coefficient of restitution. However, the heat treatment process compromises the toughness of the material, where toughness is defined as the resistance of the material to fracture under loading. Thus, even heat treated, high strength, metastable titanium alloys have limited application as face inserts due to inferior fracture properties. Thus, there is a need for face inserts composed of titanium alloys with an appropriate microstructure for better fracture properties. This requires a proper balance between strength and toughness (resistance to fracture), without a substantial increase in the costs associated with manufacturing the face insert.

[0007] Several patents disclose face inserts. Anderson, U.S. Patent Numbers 5,024,437, 5,094,383, 5,255,918, 5,261,663 and 5,261,664 disclose a golf club head having a full body composed of a cast metal material and a face insert composed of a hot forged metal material.

[0008] Viste, U.S. Patent Number 5,282,624 discloses a golf club head with a cast metal body and a forged steel face insert with grooves on the exterior surface and the interior surface of the face insert and having a thickness of 3mm.

[0009] Rogers, U.S. Patent Number 3,970,236, discloses an iron club head with a formed metal face plate insert fusion bonded to a cast iron body.

[0010] Galloway, *et al.*, U.S. Patent Number 6,354,962 discloses a golf club head of a face cup design.

[0011] However, there is a need for a golf club head with a face insert that is performs better than conventional face insert club heads and provides cost savings.

Summary of Invention

[0012] The present invention overcomes the problems of the prior art by providing a golf club head that has a body with a striking plate insert composed of a titanium alloy material with at least 40% of the microstructure in the alpha phase. This allows the golf club head of the present invention to have better performance than a conventional face insert golf club head.

[0013] Having briefly described the present invention, the above and further objects, features and advantages thereof will be recognized by those skilled in the pertinent art from the following detailed description of the invention when taken in conjunction with the accompanying drawings.

Brief Description of Drawings

[0014] FIG. 1 is an exploded view of the components of a preferred embodiment of the golf club head of the present invention.

[0015] FIG. 2 is a front view of a golf club head of the present invention.

[0016] FIG. 3 is a top plan view of a golf club head of the present invention.

[0017] FIG. 4 is a side view of the heel end of a golf club head of the present invention.

[0018] FIG. 5 is side view of the toe end of a golf club head of the present invention.

[0019] FIG. 6 is a bottom plan view of a golf club head of the present invention.

[0020] FIG. 7 is a rear view of a golf club head of the present invention.

[0021] FIG. 8 a front view of a golf club head of the present invention showing the perimeter region in dashed lines.

[0022] FIG. 9 is a cross-sectional view along line 9-9 of FIG. 3.

[0023] FIG. 10 is a front view of a club head with measurement points for hardness testing.

[0024] FIG. 11 is a graph of the Rockwell C Hardness for the measurement points of the club head of FIG. 10 for three different club heads.

[0025] FIG. 12 is a graph of the inward face progression versus the number of hits at 110 miles per hour for an unaged striking plate insert as compared to an aged striking plate insert.

[0026] FIG. 13 is a graph of the inward face progression versus the number of hits at 110 miles per hour for an unaged striking plate insert.

[0027] FIG. 14 is a graph of the inward face progression versus the number of hits at 110 miles per hour for a striking plate insert treated at 1450 degrees Fahrenheit.

[0028] FIG. 15 is a graph of the inward face progression versus the number of hits at 110 miles per hour for a striking plate insert treated at 1550 degrees Fahrenheit.

[0029] FIG. 16 is a graph of the inward face progression versus the number of hits at 110 miles per hour for a striking plate insert treated at 1650 degrees Fahrenheit.

Detailed Description

[0030]

As shown in FIGS. 1-8, the golf club head of the present invention is generally designated 20. The golf club head 20 of FIGS. 1-8 is a driver, however, the golf club head of the present invention may alternatively be a fairway wood. The golf club head 20 has a body 22 that is preferably composed of a metal material such as titanium, titanium alloy, or the like, and is most preferably composed of a cast titanium alloy material. The body 22 is preferably cast from molten metal in a method such as the well-known lost-wax casting method. The metal for casting is preferably titanium or a titanium alloy such as 6-4 titanium alloy, alpha-beta titanium alloy or beta titanium alloy for forging, and 6-4 titanium for casting. Alternatively, the body 22 is composed of 17-4 steel alloy. Additional methods for manufacturing the body 22 include forming the body 22 from a flat sheet of metal, super-plastic forming the body 22 from a flat sheet of metal, machining the body 22 from a solid block of metal,

electrochemical milling the body from a forged pre-form, casting the body using centrifugal casting, casting the body using levitation casting, and like manufacturing methods.

[0031] The golf club head 20, when designed as a driver, preferably has a volume from 200 cubic centimeters to 600 cubic centimeters, more preferably from 300 cubic centimeters to 450 cubic centimeters, and most preferably from 350 cubic centimeters to 420 cubic centimeters. A golf club head 20 for a driver with a body 22 composed of a cast titanium alloy most preferably has a volume of 380 cubic centimeters. The volume of the golf club head 20 will also vary between fairway woods (preferably ranging from 3-woods to eleven woods) with smaller volumes than drivers.

[0032] The golf club head 20, when designed as a driver, preferably has a mass no more than 215 grams, and most preferably a mass of 180 to 215 grams. When the golf club head 20 is designed as a fairway wood, the golf club head preferably has a mass of 135 grams to 180 grams, and preferably from 140 grams to 165 grams.

[0033] The body 22 has a crown 24, a sole 26, a ribbon 28, and a front wall 30 with an opening 32. The body 22 preferably has a hollow interior 34. The golf club head 20 has a heel end 36, a toe end 38, and an aft end 37. A shaft, not shown, is placed within a hosel, not shown, at the heel end 36. In a preferred embodiment, the hosel is internal to the body 22, and the shaft extends to the sole 26.

[0034] The golf club head 20 has striking plate insert 40 that is attached to the body 22 over the opening 32 of the front wall 30. The striking plate insert 40 preferably is composed of a formed titanium alloy material. Such titanium materials include titanium alloys such as 6-22-22 titanium alloy and Ti 10-2-3 alloy, Beta-C titanium alloy, all available from RTI International Metals of Ohio, SP-700 titanium alloy (available from Nippon Steel of Tokyo, Japan), DAT 55G titanium alloy available from Diado Steel of Tokyo, Japan, and like materials. The preferred material for the striking plate insert 40 is a heat treated 6-22-22 titanium alloy which is a titanium alloy composed by weight of titanium, 6% aluminum, 2% tin, 2% chromium, 2% molybdenum, 2% zirconium and 0.23% silicon. The titanium alloy will have an alpha phase in excess of 40% of the overall microstructure. As shown in FIG.1, the striking plate insert 40 typically has a plurality of scorelines 45 thereon.

[0035] As shown in FIG. 1, the striking plate insert 40 is preferably welded to the front wall 30 of the body 22, thereby covering the opening 32. A plurality of tabs 47, preferably three, align the striking plate insert 40 for the welding process. Alternatively, the striking plate insert 40 is press-fitted into the opening 32.

[0036] In a preferred embodiment, the striking plate insert 40 has uniform thickness that ranges from 0.040 inch to 0.250 inch, more preferably a thickness of 0.080 inch to 0.120 inch, and is most preferably 0.108 inch for a titanium alloy striking plate insert 40.

[0037] The present invention is directed at a golf club head that has a high coefficient of restitution thereby enabling for greater distance of a golf ball hit with the golf club head of the present invention. The coefficient of restitution (also referred to herein as "COR") is determined by the following equation:

[0038]

$$e = \frac{v_2 - v_1}{U_1 - U_2}$$

[0039] wherein U_1 is the club head velocity prior to impact; U_2 is the golf ball velocity prior to impact which is zero; v_1 is the club head velocity just after separation of the golf ball from the face of the club head; v_2 is the golf ball velocity just after separation of the golf ball from the face of the club head; and e is the coefficient of restitution between the golf ball and the club face.

[0040] The values of e are limited between zero and 1.0 for systems with no energy addition. The coefficient of restitution, e, for a material such as a soft clay or putty would be near zero, while for a perfectly elastic material, where no energy is lost as a result of deformation, the value of e would be 1.0. The present invention provides a club head 20 preferably having a coefficient of restitution preferably ranging from 0.80 to 0.87, and more preferably from 0.82 to 0.86, as measured under standard USGA test conditions.

[0041]

The depth of the club head 20 from the striking plate insert 40 to the aft-end 37

preferably ranges from 3.0 inches to 4.5 inches, and is most preferably 3.75 inches. The height, H, of the club head 20, as measured while in address position, preferably ranges from 2.0 inches to 3.5 inches, and is most preferably 2.50 inches or 2.9 inches. The width, W, of the club head 20 from the toe end 38 to the heel end 36 preferably ranges from 4.0 inches to 5.0 inches, and more preferably 4.7 inches.

[0042] The center of gravity and the moments of inertia of the golf club head 20 may be calculated as disclosed in co-pending U.S. Patent Application Number 09/796,951, filed on February 27, 2001, entitled High Moment Of Inertia Composite Golf Club, and hereby incorporated by reference in its entirety. In general, the moment of inertia, Izz, about the Z axis for the golf club head 20 will preferably range from 2700g-cm ^{2} to 4000g-cm ^{2} , more preferably from 3000g-cm ^{2} to 3800g-cm ^{2} . The moment of inertia, Iyy, about the Y axis for the golf club head 20 will preferably range from 1500g-cm ^{2} to 3500g-cm ^{2} .

[0043] One process for forming the golf club head 20 begins with formation of the striking plate insert 40. A hot rolled sheet of 6-22-22 titanium alloy is first solution treated and ground. Then, the sheet is chemically etched to remove approximately 0.003 inch of material. Next, a striking plate insert is cut from the sheet and formed for further processing. Next, the striking plate insert is either heat treated, chemically etched and welded to the body, or welded to the body, heat treated and chemically etched (approximately 0.001 inch removal). Those skilled in the pertinent art will recognize that variations of this process may be used to achieve a striking plate insert for a club head of the present invention.

[0044]

As mentioned previously, toughness is defined as the resistance of a material to fracture. Failure of a striking plate insert is defined as cracking of the insert or permanent deformation of the insert in an amount greater than 0.010 inch inward from its non-deformed state. FIG. 10 illustrates the hardness measurement points of a club head. FIG. 11 is a graph of the Rockwell C hardness of the various points from FIG. 10 for a striking plate insert composed of SP700 titanium alloy and heat treated at 480 degrees Celsius (896 degrees Fahrenheit) for two hours, for a striking plate insert composed of SP700 titanium alloy and heat treated at 560 degrees Celsius (1040 degrees Fahrenheit) for two hours, and for an unaged striking plate insert

composed of SP700 titanium alloy. FIG. 12 is a graph of the inward face progression versus the number of hits for the unaged striking plate insert composed of SP700 titanium alloy as compared to the striking plate insert composed of SP700 titanium alloy heat treated at 480 degrees Celsius for two hours. Thus, the heat treatment creates a tougher face insert.

[0045] FIG. 13 is a graph of the inward face progression versus the number of hits for an unaged striking plate insert composed of 6-22-22 titanium alloy. FIGS. 14, 15 and 16 are graphs of the inward face progression versus the number of hits for striking plate inserts composed of 6-22-22 titanium alloy solution treated in a vacuum for thirty minutes at 788 degrees Celsius (1450 degrees Fahrenheit), 843 degrees Celsius (1550 degrees Fahrenheit) and 899 degrees Celsius (1650 degrees Fahrenheit), respectively. Following the solution treatment, the striking plate inserts 40 are aged at 510 degrees Celsius (950 degrees Fahrenheit) for eight hours. The solution treatment and aging allows for a reduction in the inward face progression.

[0046] From the foregoing it is believed that those skilled in the pertinent art will recognize the meritorious advancement of this invention and will readily understand that while the present invention has been described in association with a preferred embodiment thereof, and other embodiments illustrated in the accompanying drawings, numerous changes, modifications and substitutions of equivalents may be made therein without departing from the spirit and scope of this invention which is intended to be unlimited by the foregoing except as may appear in the following appended claims. Therefore, the embodiments of the invention in which an exclusive property or privilege is claimed are defined in the following appended claims.